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PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE 6-24-02

Applicant:	Junko Kohno	**Examiner:**	L. C. Cruz
Serial No:	09/832,630	**Art Unit:**	2827
Filed:	April 11, 2001	**Docket:**	12516Z
For:	SEMICONDUCTOR DEVICE AND METHOD FOR MANUFACTURING SAME	**Dated:**	June 13, 2002

Assistant Commissioner for Patents
United States Patent and Trademark Office
Washington, D.C. 20231

RESPONSE UNDER 37 C.F.R. § 1.111

Sir:

In response to the Office Action of March 13, 2002, the applicants respectfully present the following Amendment and Remarks as set forth herein below:

IN THE SPECIFICATION:

Please amend the specification on page 12, lines 9-19, to read as follows:

B1

The above-described first embodiment of the present invention has the following meritorious effects. FIG. 7 schematically shows the effect of the first embodiment of the present invention. Referring to FIG. 7, heat 13 evolved from an active element is radiated not only from the source electrode 4 but also from the drain electrode 3 via the

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Dated: June 13, 2002

Mishelle Mustafa

electrically conductive member 6 and the aluminum nitride 5 exhibiting high thermal conductivity. Thus, the heat 13 evolved from the active element is radiated via two channels to improve the thermal dissipation efficiency higher than is possible with the conventional device.

IN THE CLAIMS:

Please amend claim 3 to read as follows:

B2

3. (Twice Amended) A semiconductor device wherein a first terminal of an active element is connected via a thermally and electrically conductive member to a heat sink member, and a second terminal of the active element transmits heat to said heat sink member via at least a thermally conductive electrically insulating member interposed in between said second terminal of the active element and the heat sink member such that a void is formed between said thermally and electrically conductive member and said thermally conductive electrically insulating member.

Please amend claim 10 to read as follows:

B3

10. (Twice Amended) A semiconductor device as defined in claim 21 wherein said thermally conductive electrically insulating member is arranged on at least one of (a) a terminal surface of said active element and (b) a surface of said heat sink member [side of the package] used for mounting the active element.

Please amend claim 21 to read as follows:

B4

21. (Amended) A semiconductor device comprising:

a heat sink member having a thermally and electrically conductive protrusion formed thereon;

an active element having a plurality of terminals; and

B4
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a thermally conductive electrically insulating member formed of a single insulating layer on the active element and connecting one of the plurality of terminals of said active element to the heat sink member, said thermally and electrically conductive protrusion connecting another one of said plurality of terminals of said active element to the heat sink member.

REMARKS

Reconsideration of this application based on the foregoing Amendment and the following Remarks is respectfully requested.

Drawings:

The Examiner has accepted the drawing changes presented in the April 11, 2001 Request for Approval of Drawing Changes.

In response, the applicants are enclosing corrected versions of FIGS. 9 and 11 showing character 14.

35 U.S.C. § 112, Second Paragraph Rejections: Claims 3, 10 and 21

The Examiner has rejected claims 3-21 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter the applicant regards as the invention.

The applicants respectfully call to the Examiner's attention that only apparatus claims 3, 6, 10 and 21 are in this continuation application. The original claims 1, 2, 4, 5, 7, 11 and 12 are now claims 1-7 of U.S. Patent No. 6,259,156 B1 issued July 10, 2001. The original claims 8 and 9 were cancelled. The remaining claims 12-20 are method claims which are part of a separate divisional application.

Specifically, the Examiner rejects claim 1 (*sic, actually claim 3)* because in the phrase "via an insulating member interposed in between", the phrase "in between" makes it confusing as to what exactly the insulating member is "interposed in between" of.

In response, the applicants have amended claim 3 to add the limitation that the electrically conductive member is both *a thermally and electrically conductive member (i.e., Au protrusion or plating 11).* Page 11, line 24, to page 12, line 1, discloses that a metal such as Au is then grown by, for example, plating, to form an electrically conductive member (layer) 6. It is well known to those of ordinary skill in the art that metals such as gold are both thermally and electrically conductive. Therefore, no new matter has been added.

The applicants have also added the limitation that the insulating member is both *a thermally conductive electrically insulating member*, as shown in FIGS. 8 and 9. Page 11, lines 7-10, of the specification discloses that aluminum nitride 5 is an example of an insulating member that has high electrical insulating properties and thermal conductivity. In other words, aluminum nitride is both thermally conductive and electrically insulating. Therefore, no new matter has been added.

To specifically address the Examiner's rejection, claim 3 has been amended to recite "a thermally conductive electrically insulating member interposed in between said second terminal of the active element and the heat sink member," so that the claim recites that the aluminum nitride representing a thermally conductive electrically insulating member is interposed in between the second terminal of the active element and the heat sink member. No new matter has been added.

The Examiner rejects claim 10 because the phrase "the package" lacks antecedent basis, and also it is unclear what is meant by "heat sink member side."

In response, the applicants have amended claim 10 to recite "said thermally conductive electrically insulating member is arranged on at least one of (a) a terminal surface of said active element and (b) a surface of said heat sink member used for mounting the active element.", so that it is clear that it is the aluminum nitride that is arranged on a surface of the heat sink member used for mounting the active element. The applicants have also deleted the phrase "the package". No new matter has been added.

The Examiner has rejected claim 21 because the phrase "the other" in "the other of the first and second terminals" lacks antecedent basis.

In response, the applicants have amended claim 21 to recite: "said thermally and electrically conductive protrusion connecting another one of said plurality of terminals of said active element to the heat sink member." No new matter has been added.

35 U.S.C. § 102(b) Rejections: Claims 3, 6, 10 and 21

The Examiner has rejected claims 3, 6, 10 and 21 under 35 U.S.C. § 102(b) as being anticipated by Kato (U.S. 5,536,972 – filed December 7, 1994 – issued July 16, 1996).

With respect to claim 3, the Examiner alleges that Kato discloses the limitations of a semiconductor device wherein a first terminal of an active element (Kato resistor 3 or MOS-FET 5) is connected via an electrically conductive member to a heat sink member (Kato heat radiating container 10) and wherein a second terminal of the active element transmits heat to said heat sink member (Kato 10) via at least an insulating member (Kato alumina insulating plates 12 – high heat conductor and high electrical insulator) wherein a void is formed between said conductive member and said insulating member.

Based on the amendment to claim 3, the applicants respectfully maintain that Kato does not disclose a first terminal of an active element connected via *a thermally and*

electrically conductive member (the present application of Kohno et al, Au plating 11 of FIG. 8), while at the same time a second terminal of an active element connected via *a thermally conductive electrically insulating member (the present application of Kohno et al aluminum nitride 5).*

Furthermore, in Kato, both the first and second terminals, active element resistor 3 and MOS-FET 5, respectively are connected to the heat sink 10 by the alumina insulating plates 12, which are high thermal conductors and electrical insulators, as disclosed in Kato, column 5, lines 16-20. However, the electrical connections to the active element resistor 3 and MOS-FET 5 are formed only by thin aluminum wires 6. Therefore, heat dissipation is very limited in Kato because the heat transfer occurs through the thin aluminum wires 6.

In contrast, in the present invention recited by claim 3, there is significantly increased heat dissipation from the heat sink member (9) and the active (heat generating) elements (drain and source electrodes 3 and 4, respectively).

Claim 3, as amended, recites a thermally and electrically conductive member connecting to a first terminal, which is not disclosed by Kato, and a thermally conductive electrically insulating member connecting to a second terminal. Therefore, claim 3, as amended, and claim 6 patentably distinguish over Kato.

With respect to claim 21, the Examiner alleges that Kato discloses a semiconductor device comprising a heat sink member (Kato 10) having a protrusion (30c) formed thereon, and that one of said terminals connecting the heat sink member is connected via the protrusion, as recited by claim 21.

In response, claim 21 has been amended to recite that the protrusion is a "thermally and electrically conductive protrusion" since it is a protrusion of metal formed by Au plating on a portion in register with the source electrode on the heat sink side of the package, as disclosed in the specification on page 13, lines 2-5. Also, claim 21 has been further amended by reciting that "said thermally and electrically conductive protrusion connecting another one of said plurality of terminals of said active element to the heat sink member [via the protrusion]."

The applicants respectfully maintain that in Kato, the protrusion or pin 30c cited by the Examiner does not connect the terminal (an electrode or active element) to the heat sink member but rather the pin 30c connects aluminum plate 30 to the heat radiating container 10 (or heat sink). Also, as is the case for claim 3, Kato does not disclose that a thermally conductive electrically insulating member, i.e., aluminum nitride 5 of the present application, connects one of the terminals to the heat sink member while a thermally and electrically conductive protrusion connects another one of the terminals to the heat sink member, as recited by claim 21.

Instead, in Kato, both the first and second terminals 3 and 5 are connected to the heat sink 10 by the alumina insulating plates 12, which are high thermal conductors and electrical insulators, as disclosed in Kato, column 5, lines 16-20. Therefore, claims 21 and 10 patentably distinguish over Kato.

Specification:

Under the applicants' own initiative, the applicants have amended the paragraph on page 12, lines 9-19.

The proposed amendment to the specification is simply to provide a definition in the specification for item number 13 as the heat 13 evolving from an active element, as illustrated in FIG. 7. Also, a minor editorial correction has been made. No new matter has been added.

The foregoing Amendment and Remarks establish the patentable nature of all of the claims remaining in the application, i.e., claims 3, 6, 10 and 21. No new matter has been added, wherefore, early and favorable reconsideration and issuance of a Notice of Allowance are respectfully requested.

Respectfully submitted,

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Encl. (Version with Markings to Show Changes Made and
Corrected Versions of Figs. 9 and 11)